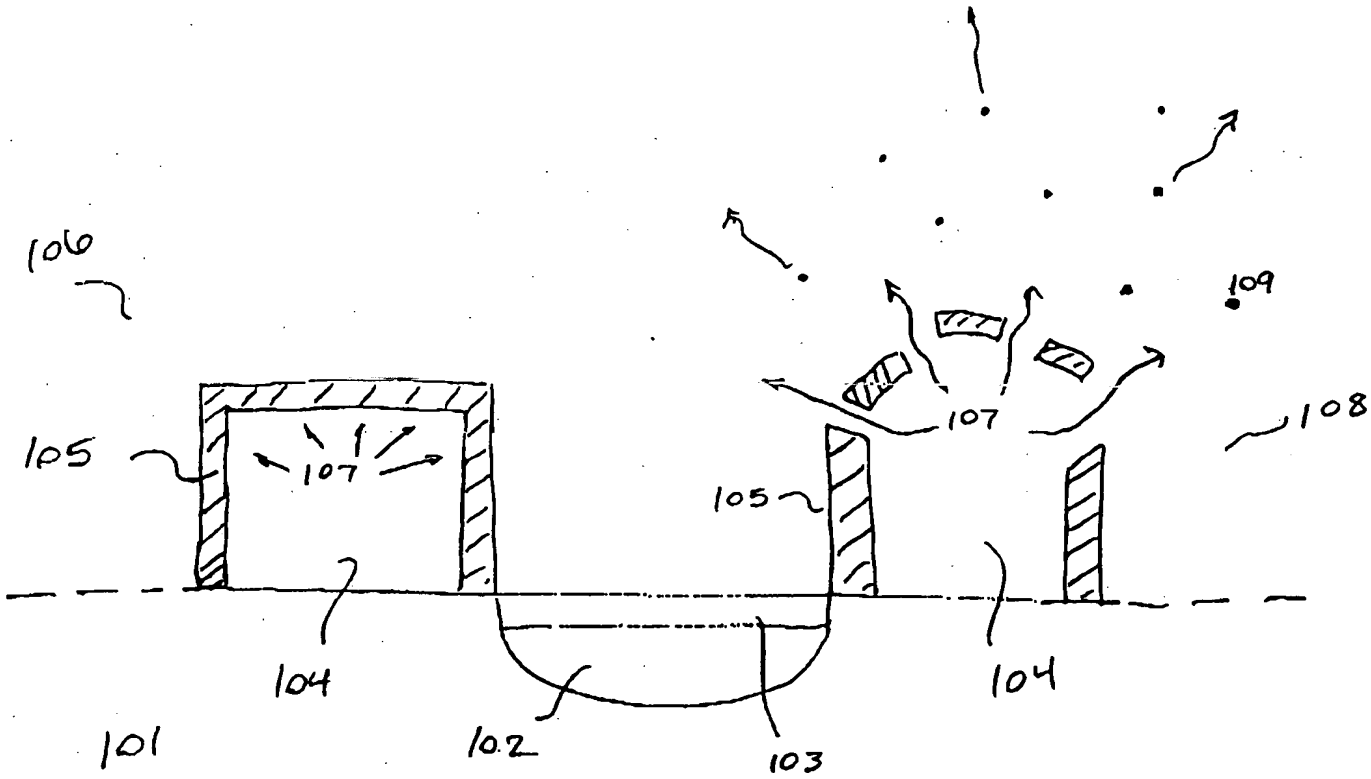

Fig. 1

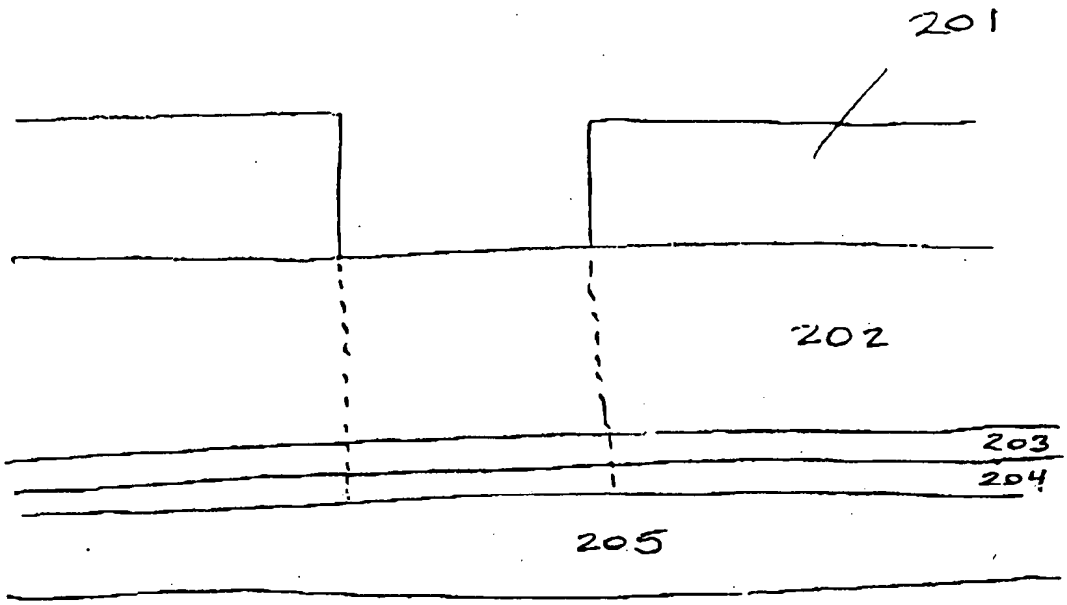

Fig 2A

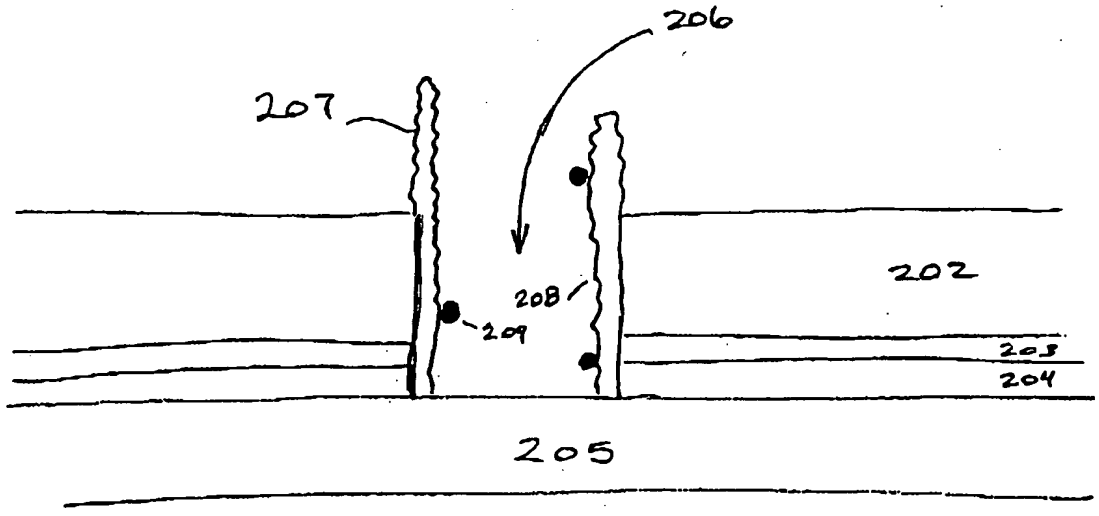

Fig 2B

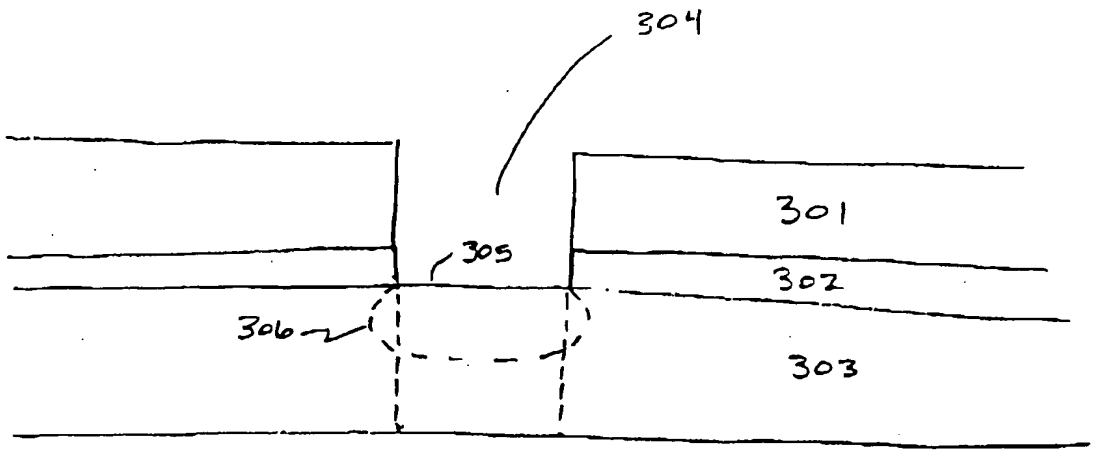

Fig. 3A

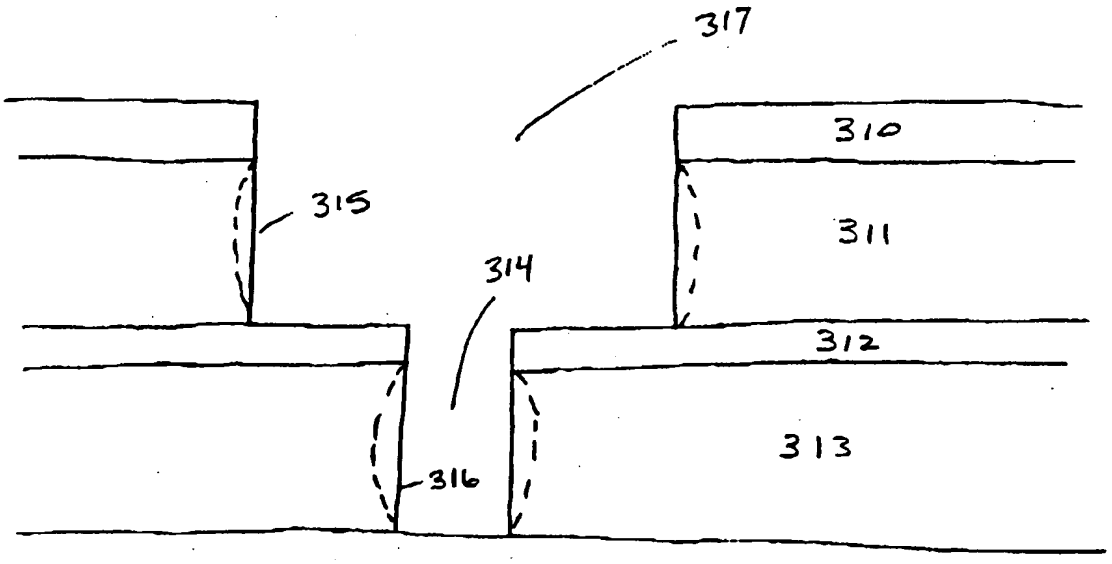

Fig 3B

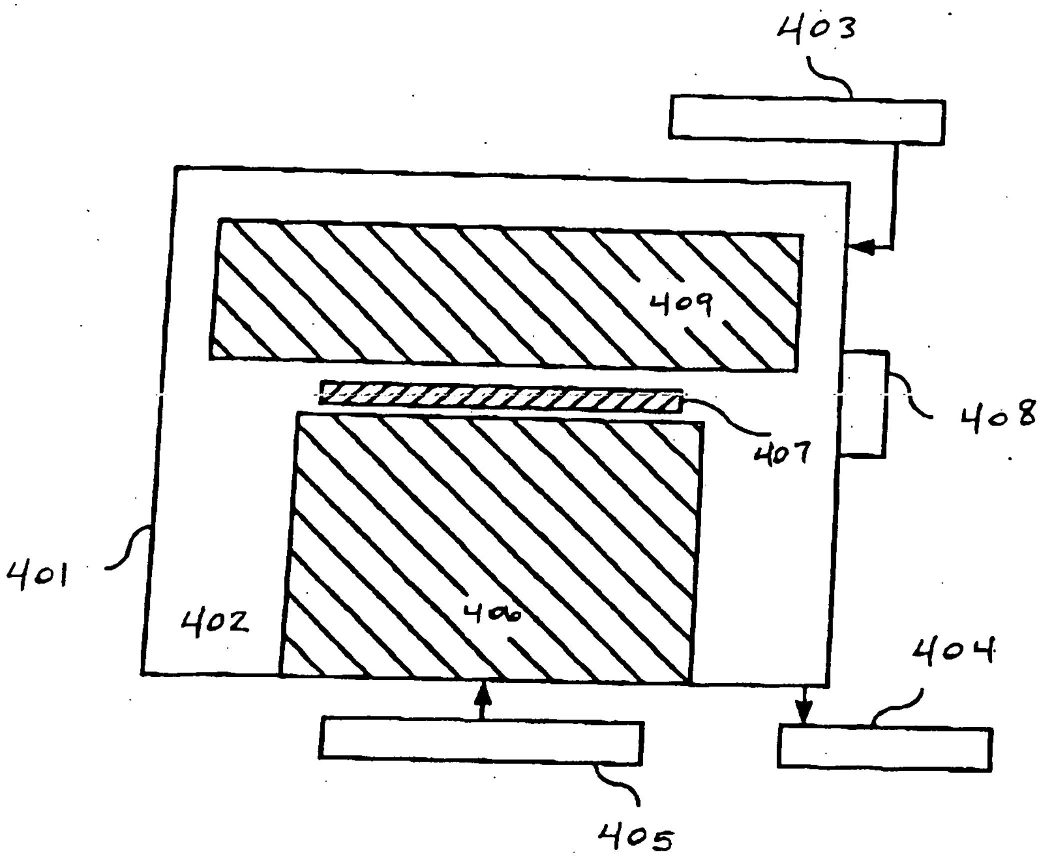

Fig. 4

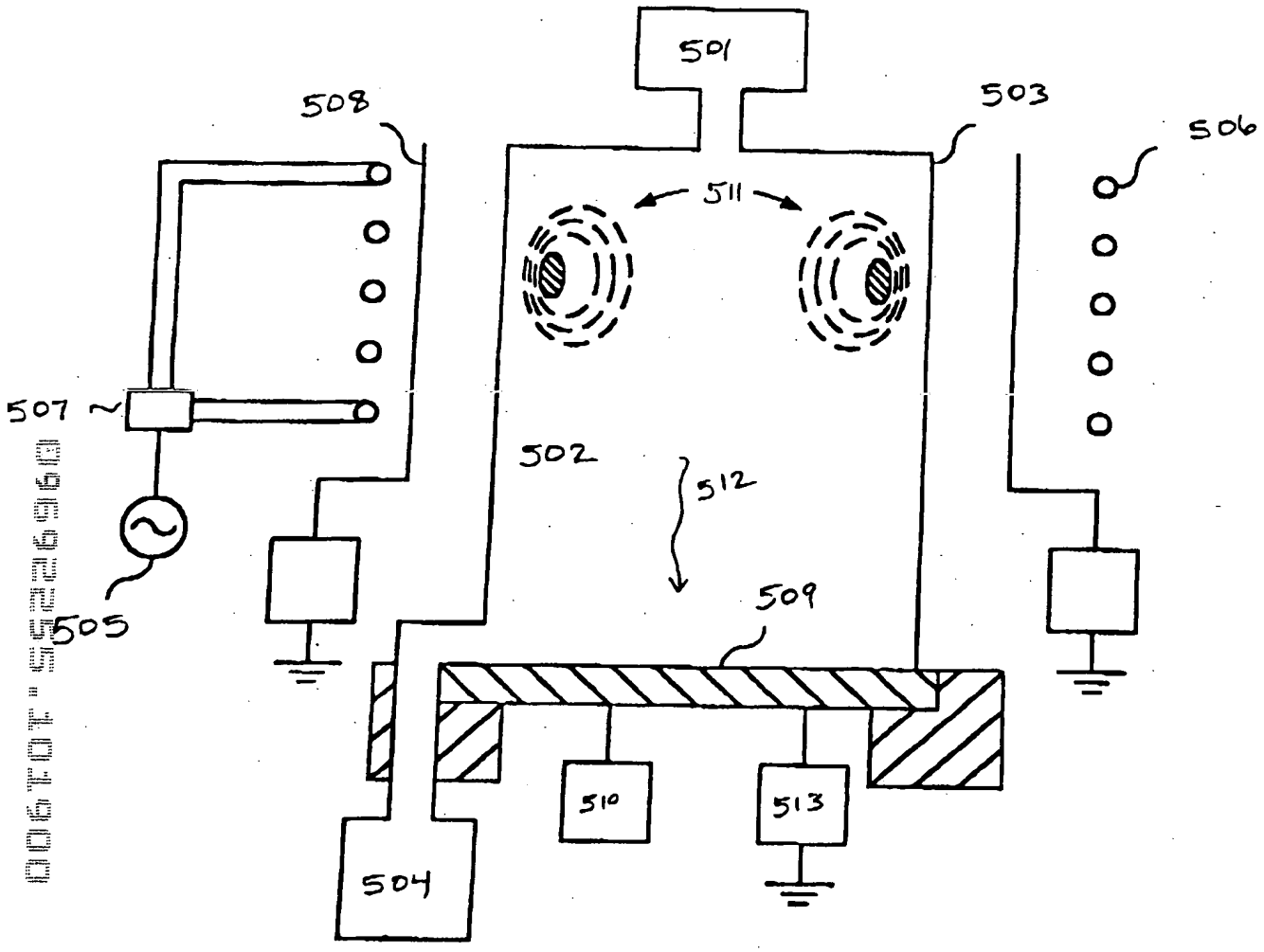

Fig. 5

Figure 6

Parameter	Feedgas compositions for exemplary HDIS processes Embodiment #1	Embodiment #2	Embodiment #3
Principal gas	oxygen	hydrogen	water vapor
Inert diluent gas	any noble gas, nitrogen	helium, argon, or nitrogen	helium, argon, or nitrogen
Additive gases	water vapor oxides of nitrogen oxides of sulfur methyl, ethyl alcohol hydrogen methane ammonia methyl, ethyl amine carbon dioxide formaldehyde (oxides of sulfur, nitrous oxide, nitric oxide, nitrogen dioxide)	oxygen methane ammonia water vapor methyl alcohol ethyl alcohol oxides of nitrogen (nitrous oxide, nitric oxide, nitrogen dioxide) oxides of sulfur; flows of the additive gases of the order or less for hydrogen	oxygen methane ammonia water vapor methyl alcohol ethyl alcohol oxides of nitrogen (nitrous oxide, nitric oxide, nitrogen dioxide) oxides of sulfur; flows of the additive gases less than about 30% of the total gas flow
Total gas flow	less than 3,000 SCCM	less than 3,000 SCCM	less than 3,000 SCCM
Pressure	≤ 200 mTorr	≤ 200 mTorr	≤ 200 mTorr
Source power to plasma	1,000 to 2,500 watts at 13.56 MHz	1,000 to 2,500 watts at 13.56 MHz	1,000 to 2,500 watts at 13.56 MHz
Bias power to pedestal	0.1 to 2.0 watts/cm^2	0.1 to 2.0 watts/cm^2	0.1 to 2.0 watts/cm^2
Wafer temperature	≤ 100° C	≤ 100° C	≤ 100° C

Figure 7

Parameter	Feed gas compositions for exemplary via clean processes		
	Embodiment #1	Embodiment #2	Embodiment #3
Principal gas	oxygen	hydrogen	water vapor
Inert diluent gas	any noble gas, nitrogen	helium, argon, or nitrogen	helium, argon, or nitrogen
Additive gases	~~water vapor~~ oxides of nitrogen oxides of sulfur methyl, ethyl alcohol hydrogen methane ammonia methyl, ethyl amine carbon dioxide formaldehyde (oxides of sulfur, nitrous oxide, nitric oxide, nitrogen dioxide), plus gases which contain fluorine or other halogen at up to 20% of the total gas flow rate	~~oxygen~~ methane ammonia water vapor methyl alcohol ethyl alcohol oxides of nitrogen (nitrous oxide, nitric oxide, nitrogen dioxide) oxides of sulfur; flows of the additive gases of the order or less for hydrogen, plus gases (less than 10% of total flow) containing fluorine or other halogen	~~oxygen~~ methane ammonia water vapor methyl alcohol ethyl alcohol oxides of nitrogen (nitrous oxide, nitric oxide, nitrogen dioxide) oxides of sulfur; flows of the additive gases no more than 30% of the total gas flow, plus fluorinated gas or other halogenated gases up to 20% of total flow
Total gas flow	less than 3,000 SCCM	less than 3,000 SCCM	less than 3,000 SCCM
Pressure	≤ 200 mTorr	≤ 200 mTorr	≤ 200 mTorr
Source power to plasma	1,000 to 2,500 watts at 13.56 MHz	1,000 to 2,500 watts at 13.56 MHz	1,000 to 2,500 watts at 13.56 MHz
Bias power to pedestal	0.1 to 2.0 watts/cm^2	0.1 to 2.0 watts/cm^2	0.1 to 2.0 watts/cm^2
Wafer temperature	≤ 100° C	≤ 100° C	≤ 100° C

Figure 8

Parameter	Exemplary embodiment of a two-step HDIS process Step 1 Inductively coupled (or other high density) plasma source	 Step 2 Conventional ashing process tool
Gas flows: oxygen	40 to 150 SCCM	greater than 1,000 SCCM
Pressure	2 to 10 mTorr	1 Torr
Source power (to plasma)	1.0 to 2.5 kW at 13.56 MHz	1 kW
Bias power to wafer pedestal	25 to 150 watts at 13.56 MHz	none
Wafer temperature	≤ 100° C	about 250° C
Time of etch	30 seconds (to etch the crust, and only a small amount of the bulk photoresist lying beneath the crust)	to completion (this step comprises the removal of the bulk of the photoresist under the crust, and is carried out in a conventional manner)

Figure 9

Parameter	Exemplary HDIS process when hardened inclusions are present		
	Step 1 Crust etch	Step 2 Crust overetch	Step 3 Removal of bulk photoresist
Principal gas	predominantly oxygen	predominantly oxygen	predominantly oxygen
Pressure	5 mTorr	5 mTorr	1.1 Torr
Source power to plasma	2,000 watts at 13.56 MHz	2,000 watts at 13.56 MHz	800 watts at 13.56 MHz
DC Bias voltage to pedestal	≤ 50 volts	≤ 50 volts	none
Wafer temperature	≤ 100° C	≤ 150° C	250° C
Time of etch	30 seconds or less	10 seconds or less	30 seconds or less

Figure 10

Parameter	Exemplary HDIS process with hot pedestal	
	Step 1 crust removal	Step 2 stripping of bulk photoresist in the same chamber
Gas flows: oxygen additives	less than about 500 SCCM any additive gas from figure 6 except fluorine containing gases	1 to 3 SLM any additive gas from figure 6
Pressure	≤ 50 mTorr	1 Torr
Source power (to plasma)	≥ about 200 watts	800 to 1200 watts
Wafer temperature	150° to 250° C	about 250° C

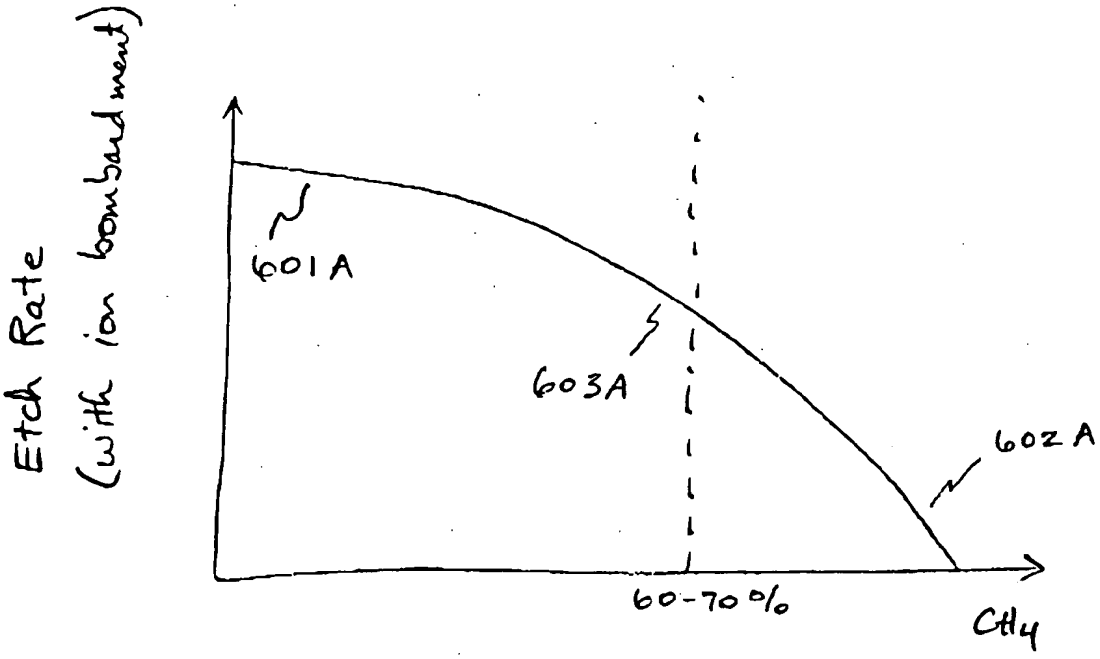

Fig 11A

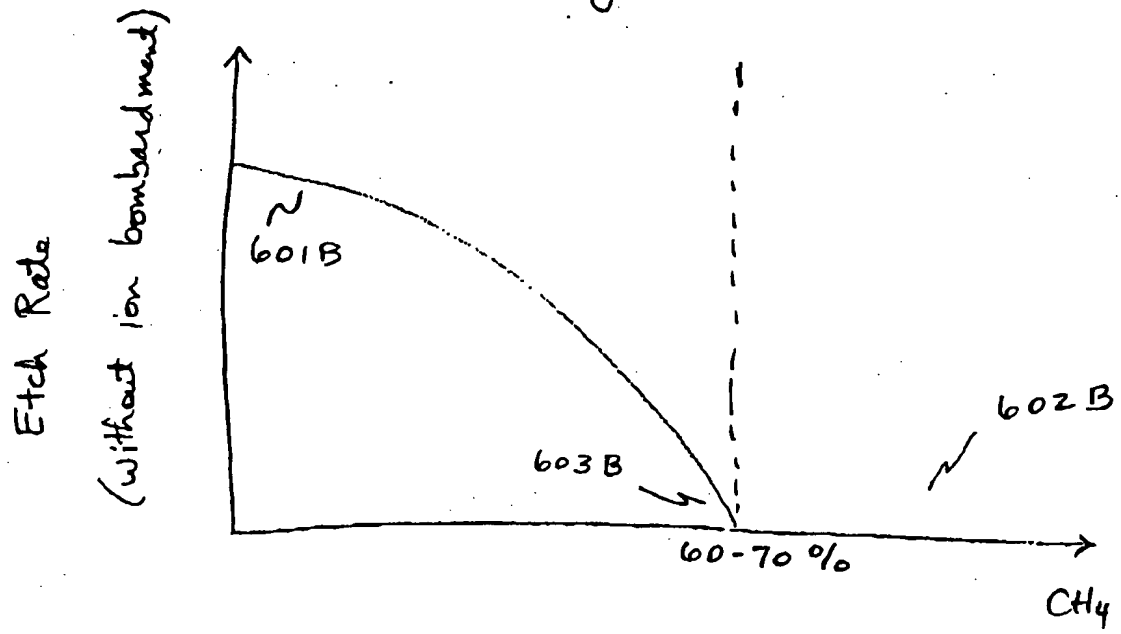

Fig. 11B

Figure 12

Parameter	Exemplary processes for stripping photoresist in the presence of silicon and carbon-containing low-k dielectrics (e.g. MSSQ and SiOC)		
	Embodiment #1	Embodiment #2	Embodiment #3
Principal gas	hydrogen, oxygen, methane	hydrogen	oxygen
Inert diluent gas	any noble gas, nitrogen	any noble gas, nitrogen	
Additive gases	ammonia, methyl alcohol, water vapor, and fluorine-containing gases (e.g., C_2F_2, CHF_3, and CH_2F_2)		
Total gas flow	between 10 and 1,000 SCCM	less than 3,000 SCCM	
Pressure	2 to 200 mTorr	≤ 200 mTorr	5 mTorr
Source power to plasma	between 200 and 2,000 watts		less than 500 watts
Bias power to pedestal	0.1 to 2.0 watts/cm^2	0.1 to 2.0 watts/cm^2	0.1 to 2.0 watts/cm^2
Wafer temperature	≤ 100° C	between 100 and 150° C	

Figure 13

Parameter	Exemplary processes for stripping photoresist in the presence of silicon and carbon-containing low-k dielectrics (e.g. MSSQ and SiOC)		
	Step 1 version A	Step 1 version B	Step 2
Principal gas	20 SCCM oxygen 40 SCCM methane	30 SCCM oxygen	hydrogen-based or oxygen
Inert diluent gas			helium or nitrogen
Additive gases		ammonia, silane, methyl or ethyl alcohol, water vapor, nitrogen or nitrogen oxides, carbon dioxide	water vapor or alcohols
Total gas flow	between 10 and 1,000 SCCM	less than 100 SCCM	between 10 and 1,000 SCCM
Pressure	5 mTorr	2 to 10 mTorr	2 to 200 mTorr
Source power to Plasma	2,000 watts	200 to 2,000 watts	200 to 2,000 watts
Bias power to pedestal	75 watts	0.1 to 2.0 watts/cm^2	0.1 to 2.0 watts/cm^2

Figure 14

Parameter	Branched and caged structures of non-carbon containing silsesquioxanes (HSQ and FOx™)
Gas flows: oxygen	less than about 1,000 SCCM can be substantially oxygen
Pressure	2 to 200 mTorr
Source power (to plasma)	200 to 2,000 watts
Bias power to wafer pedestal	0.1 to 1.0 watts/cm^2
Wafer temperature	≤ 100° C

Figure 15

Parameter	Exemplary processes for stripping photoresist in the presence of organic dielectrics		
	Generic process	Specific process step 1	Specific process step 2
Principal gas	oxygen flow less than 50% of total, hydrogen containing gases, net reducing atmosphere	2/3 water vapor; 1/3 methane	60% methane 40% oxygen
Additive gases	hydrocarbons such as methane, ethane, propane, and butane; small cyclic hydrocarbons including cyclic butane, cyclopentane, cyclohexane, and benzene; alcohols such as methanol, ethanol, and propanol; and other gases such as carbon dioxide, hydrogen, nitrogen, ammonia, silane, disilane, TEOS, water vapor, formaldehyde, acetaldehyde, ethylene oxide.		
Total gas flow	less than about 1,000 SCCM	100 SCCM	100 SCCM
Pressure	1 to 200 mTorr	2 to 10 mTorr	2 to 10 mTorr
Source power to Plasma	200 to 2,000 watts	2,000 watts	2,000 watts
Bias power to pedestal	0.1 to 2.0 watts/cm^2	100 watts	100 watts